Biofuels at Sea

The Maritime Professional's Guide to Alternative Fuels

BUNKERING101

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Bunkering101

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Preface

Biofuels at Sea: The Maritime Professional's Guide to Alternative Fuels is written for the people who make fuel procurement decisions with money on the line — not in theory, but on the ground, at the bunker stem, in the chartering office, and on the bridge.

This book assumes you understand the fundamentals of marine fuel procurement. If you do not, start with *Bunkering 101: A Commercial Guide to Marine Fuel Procurement*, which covers the full landscape of conventional bunkering — from pricing and contracts to delivery operations and claims. This book goes deep on one subject: biofuels, and everything that makes them different from the VLSFO and LSMGO you already know.

What this book covers:

- The chemistry and classification of marine biofuels (FAME, HVO, and beyond)
- Feedstock economics — the real constraint on biofuel adoption
- How to procure biofuel bunkers without getting burned
- Engine compatibility, storage stability, and fuel management
- Regulatory compliance across IMO, EU, and regional frameworks
- Sustainability certification and the documentation trail
- Composite case studies of biofuel bunkering gone wrong — and right

How to use this book:

Each chapter is self-contained enough to be read independently, but they build on each other. If you are a bunker buyer, start with Chapters 2 and 4. If you are a chief engineer, start with Chapters 5 and 6. If you are a compliance officer, start with Chapter 7. Everyone should read Chapter 10 (Case Studies) — the lessons there are expensive to learn firsthand. The appendices provide quick-reference tables, checklists, calculation worksheets, and documentation templates designed to be copied and used on the job.

A note on currency: Prices, premiums, and regulatory penalties cited in this book reflect market conditions as of early 2026. Biofuel markets move fast. Use the frameworks and calculation methods, not the specific numbers, as your guide.

For questions, corrections, or feedback: contact@bunkering101.com

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Chapter 1

The Biofuel Imperative

What this chapter covers: The regulatory forces driving biofuel adoption in shipping, the current state of the market, why biofuels are the most practical near-term decarbonization pathway, and what the market looks like through 2035.

Prerequisites: None. This chapter is self-contained.

Key takeaway: Biofuels are not a future technology waiting for a breakthrough. They are available today, they work in existing engines, and the regulatory economics are shifting rapidly in their favor. The question is no longer *whether* your fleet will burn biofuel — it is *when* and *how much*.

1.1 The Regulatory Freight Train

Maritime shipping produces approximately 1.05 billion tonnes of CO2 annually — roughly 3% of global greenhouse gas emissions. For decades, the industry faced no binding emissions targets. That changed.

1.1.1 IMO's Revised GHG Strategy (MEPC 80, July 2023)

In July 2023, the International Maritime Organization adopted the **2023 IMO Strategy on Reduction of GHG Emissions from Ships** at MEPC 80. This replaced the 2018 Initial Strategy and dramatically raised ambition:

Milestone	Target
2030	Reduce total annual GHG emissions by **at least 20%, striving for 30%**, vs. 2008 baseline
2030	Zero or near-zero GHG fuels to represent **5–10%** of shipping's total energy use
2040	Reduce total annual GHG emissions by **at least 70%, striving for 80%**, vs. 2008 baseline
2050	**Net-zero GHG emissions** by or around 2050

Table 1.1: IMO Revised GHG Strategy key milestones (MEPC 80, July 2023)

The 2008 baseline — established by the IMO Fourth GHG Study — puts international shipping emissions at approximately 1,052 million tonnes of CO2. A 20% reduction by 2030 means cutting roughly 210 million tonnes. A 70% reduction by 2040 means eliminating 735 million tonnes.

These are not aspirational guidelines. They are the framework within which the IMO is building **binding mid-term measures**: a Global Fuel Standard (GFS) and an economic mechanism (effectively a global carbon price on shipping).

The IMO Global Fuel Standard sets maximum GHG intensity limits for marine fuels on a well-to-wake (WtW) basis — meaning it counts emissions from fuel production, transport, and combustion, not just what comes out of the funnel. Proposed reduction trajectory:

Year	GHG Intensity Reduction (indicative)
2028	Baseline established; first compliance period
2030	~8–10% reduction
2035	~20–25% reduction
2040	~50–65% reduction
2045	~80–90% reduction
2050	Net-zero

Table 1.2: IMO Global Fuel Standard — indicative GHG intensity reduction trajectory

The compliance mechanism uses a **surplus/deficit unit system**. Ships burning lower-GHG fuels generate surplus units. Ships exceeding the limits incur deficits that must be settled — either by trading surplus units from other vessels or by purchasing remedial units at a set price. Revenue flows to an implementation fund supporting developing nations.

Translation: if your vessel burns fossil VLSFO and the GFS tightens, you pay. If you burn certified sustainable biofuel, you generate compliance credits. The economics are structural, not optional.

1.1.2 FuelEU Maritime (EU Regulation 2023/1805)

The EU did not wait for the IMO. FuelEU Maritime took effect **January 1, 2025**, applying to all vessels of 5,000 GT and above calling at EU ports, regardless of flag. (EEA incorporation is pending: as of the 2025 application date, Norway and Iceland are treated as third countries for FuelEU, so their ports do not yet count as EU port calls — verify current status.)

GHG intensity targets vs. the 2020 reference line (91.16 gCO2eq/MJ):

Year	Reduction	Approximate Limit
2025	-2%	~89.34 gCO2eq/MJ
2030	-6%	~85.69 gCO2eq/MJ
2035	-14.5%	~77.9 gCO2eq/MJ
2040	-31%	~62.9 gCO2eq/MJ
2045	-62%	~34.6 gCO2eq/MJ

Year	Reduction	Approximate Limit
2050	-80%	~18.23 gCO2eq/MJ

Table 1.3: FuelEU Maritime — GHG intensity reduction targets vs. 2020 reference (91.16 gCO2eq/MJ)

The penalty for non-compliance: **EUR 2,400 per tonne of VLSFO-equivalent** energy consumed in excess of the compliance limit. Penalties are collected by EMSA and directed to an Ocean Fund.

A vessel burning VLSFO at ~91 gCO2eq/MJ already exceeds the 2025 target of ~89 gCO2eq/MJ. By 2030, the gap widens to ~6 gCO2eq/MJ. By 2035, fossil VLSFO exceeds the limit by roughly 13 gCO2eq/MJ. Without a lower-carbon fuel, you pay the penalty.

How biofuels help under FuelEU: Certified sustainable biofuels derived from waste feedstocks (used cooking oil, animal fats, POME) achieve **60–90% WtW GHG reductions** vs. fossil fuel. A B24 blend (24% FAME / 76% VLSFO) can reduce a vessel's FuelEU GHG intensity by roughly 15–20%, providing compliance headroom through 2030 and beyond. A B30 blend provides even more margin.

FuelEU also allows **pooling** — vessels running biofuels generate surpluses that can offset deficits of other vessels in the same company pool. This turns biofuel adoption from a cost center into a compliance asset.

1.1.3 EU ETS for Maritime (Effective January 2024)

In parallel with FuelEU, the EU Emissions Trading System (ETS) now covers maritime. CO2 emissions from shipping are phased in:

- **2024:** 40% of emissions covered
- **2025:** 70% of emissions covered
- **2026:** 100% of emissions covered

At EU Allowance (EUA) prices of EUR 60–80/tCO2 and a VLSFO emission factor of 3.114 tCO2/MT, the cost adds approximately **EUR 190–250 per tonne** of VLSFO consumed on intra-EU voyages by 2026 (100% liability). Certified sustainable biofuels with proven WtW emissions savings receive favorable treatment — their biogenic CO2 is counted as zero under the ETS, effectively reducing the carbon cost per tonne of fuel burned.

The combined effect of FuelEU Maritime and EU ETS means that for a vessel operating in European waters, the **all-in cost** of fossil VLSFO is significantly higher than the bunker price alone. Biofuels narrow the gap — and in some compliance scenarios, are cheaper on a total-cost basis.

1.2 Why Biofuels, Why Now

The shipping industry has five realistic decarbonization pathways: biofuels, LNG, methanol, ammonia, and hydrogen. Each has merits. Only one is available today, at scale, without new engines.

1.2.1 The Comparison

Factor	Biofuels	LNG	Methanol	Ammonia	Hydrogen
Availability	Now	Now	Limited	2026–2028	2028–2030+
Engine mods	Drop-in (up to B30)	Dual-fuel required	Dual-fuel required	Under development	Fuel cells / specialized
GHG reduction (WtW)	40–90%	10–25% fossil; up to 90%+ bio-LNG	5–15% gray; 90%+ green	0% gray; 90%+ green	90–100% green
Infrastruct	Existing bunkering	Cryoger ~200 ports	~20 ports	Pilot only	Demonstration

Factor	Biofuels	LNG	Methanol	Ammonia	Hydrogen
Cost premium vs VLSFO	+25–55% (B24–B30)	-10 to +20%	+50–100% green	+100–200%+ est.	+200–400%+ est.
Retrofit	Immediate	Modera ($5–15M)	Moderate to high	Newbuild only	Newbuild only
Scalability concern	Feedstock limits	Methan slip; fossil bridge fuel	Green production limited	Green production limited; toxicity	Storage density; cost

Table 1.4: Alternative marine fuel comparison — technology readiness and deployment status (2026)

The bottom line: Biofuels are the only solution that works in the engines you already have, delivered through the infrastructure that already exists, at a price premium that regulatory compliance costs already justify.

1.2.2 The Drop-In Advantage

"Drop-in" means the fuel can be used in existing marine diesel engines without hardware modification. For FAME blends up to B30 (30% FAME / 70% VLSFO), most MAN B&W, Wärtsilä, and WinGD engines can operate on the fuel with no changes beyond potentially adjusting separator settings and monitoring fuel filters more closely.

This is not a marginal benefit. The global fleet has approximately **60,000 commercial vessels** over 1,000 GT. Replacing even a fraction of these with LNG or methanol dual-fuel engines would take decades and cost tens of billions of dollars. Biofuels let you start decarbonizing **the fleet you have**, not the fleet you wish you had.

HVO (hydrotreated vegetable oil) goes further — it is a true drop-in at any blend ratio, including 100% neat HVO, with properties nearly identical to fossil diesel. No engine modifications. No operational changes. Just swap the fuel.

1.2.3 The Regulatory Economics Are Shifting

Consider a vessel consuming 5,000 MT of fuel per year on intra-EU voyages:

Fossil VLSFO only (2026 scenario):

Cost Component	Annual Cost
VLSFO at $500/MT	$2,500,000
EU ETS at EUR 70/tCO2 (100% liability, ~3.1 tCO2/MT)	$1,085,000
FuelEU penalty (non-compliant — exceeds -2% target)	$300,000–$700,000
Total	**$3,885,000–$4,285,000**

B24 biofuel blend (2026 scenario):

Cost Component	Annual Cost
B24 at $650/MT ($500 + $150 premium)	$3,250,000
EU ETS (24% biogenic = zero; 76% fossil liable)	$825,000
FuelEU (compliant — no penalty)	$0
Total	**$4,075,000**

Table 1.5: Total cost comparison — VLSFO vs B24 on intra-EU voyages, illustrative 2026

The gap is narrower than the bunker price alone suggests. At current premiums, B24 remains marginally more expensive in this simplified scenario — but the calculation above does not include pooling benefits (where biofuel surpluses offset other vessels' deficits), charterer willingness to pay for green shipping, or the reputational value of verifiable emissions reductions.

More importantly, look at what happens as regulations tighten. By 2030, FuelEU requires -6% reduction. Fossil VLSFO cannot comply at all — the penalty grows. By 2035, the target reaches -13% to -14.5%. A vessel running B30 or B50 may still comply; a fossil-only vessel will face compounding penalties every year.

This is the core argument for biofuels: not necessarily that they are cheaper than fossil fuel today in every scenario, but that the regulatory cost of *not* using them is rising structurally, the gap is closing fast, and for vessels operating under FuelEU pooling arrangements or serving sustainability-conscious charterers, biofuels can already be cost-competitive or cheaper on an all-in basis.

1.3 The Current State of Biofuel Adoption

Biofuels in shipping are no longer experimental. They are operational. But they remain a small fraction of total marine fuel consumption.

1.3.1 Market Size

Global marine fuel consumption is approximately **300–330 million tonnes per year** across all fuel types (HFO, VLSFO, LSMGO, LNG, biofuels). Marine biofuel consumption is estimated at **0.5–1.0 million tonnes of oil equivalent per year** — roughly **0.1–0.3%** of the total by energy content.

Singapore, the world's largest bunkering port, recorded approximately **52,000 tonnes** of biofuel bunker sales in 2023 against total bunker sales of ~50 million tonnes. Volumes grew significantly in 2024 as more suppliers entered the market and MPA licensed additional biofuel bunker providers.

1.3.2 Who Is Using Biofuels

Maersk pioneered commercial-scale biofuel use through its "ECO Delivery" product, launched in 2021. Using ISCC-certified, waste-based biofuels supplied by GoodFuels, Maersk has completed hundreds of biofuel voyages across Europe-Asia routes. The product allows cargo owners to claim carbon-neutral transport — a commercial proposition, not just a compliance exercise.

CMA CGM partnered with GoodFuels for regular biofuel bunkering out of Rotterdam, integrating biofuels into its European operations.

MSC has conducted multiple biofuel trials and uses biofuels to serve cargo owners with specific sustainability requirements.

Other active users include: Hapag-Lloyd, Oldendorff Carriers, Jan De Nul, DFDS (Danish ferry operator running regular services on biofuel blends), Eastern Pacific Shipping (B24 trials in Singapore), and Virgin Voyages (cruise ship bunkered biofuel in Rotterdam).

1.3.3 The Supplier Landscape

The marine biofuel supply chain is dominated by a handful of specialized suppliers and major oil companies expanding into the space:

Supplier	Primary Product	Key Hubs
GoodFuels (FincoEnergies)	FAME blends (B20–B100), HVO	Rotterdam, European ports
BP Marine	HVO, FAME blends	Global — leveraging refinery capacity
Bunker Holding	FAME/HVO blends	Global — through subsidiary bunker suppliers
TFG Marine	FAME blends (B24+)	Singapore, European ports
Chevron	FAME/HVO blends	Singapore, US Gulf
Bomin	FAME blends	European ports

Table 1.6: Major marine biofuel suppliers (2026)

GoodFuels remains the market leader in marine biofuels, having supplied **50+ shipping companies** since its founding. The company sources ISCC EU/ISCC PLUS certified feedstocks — primarily used cooking oil (UCO), animal fat waste, and other residue streams — and has established reliable supply chains through the Port of Rotterdam.

1.3.4 What Is Being Bunkered

The most common marine biofuel blends in 2025–2026:

- **B24** (24% FAME / 76% VLSFO): The dominant blend in Singapore. Widely accepted by engine manufacturers. Minimal operational adjustments required.

- **B30** (30% FAME / 70% VLSFO): Common in European ports. At the upper end of what most engines can handle without modification.
- **B50–B100**: Available but less common. Higher blends require more attention to fuel system compatibility, storage stability, and material compatibility (see Chapters 5 and 6).
- **HVO (neat or blended)**: Growing availability. True drop-in — can replace VLSFO entirely with no operational changes. Higher cost than FAME blends.

1.4 The Path Forward: 2026–2035

1.4.1 Market Projections

DNV's Maritime Forecast projects biofuels could constitute **3–8%** of the marine fuel mix by 2030 and **10–20%** by 2040, depending on regulatory stringency and feedstock availability. The IEA's Net Zero Emissions scenario suggests biofuels could reach approximately 15% of shipping energy by 2050.

In absolute terms, this means marine biofuel consumption growing from ~0.5–1.0 million tonnes per year today to potentially **10–25 million tonnes per year by 2030** and **30–60 million tonnes per year by 2035** under aggressive regulatory scenarios.

This is a massive scaling challenge. For context, total global FAME production (all sectors — road, aviation, marine) is approximately **45–50 million tonnes per year**. Shipping competing for even 10% of global FAME production would reshape feedstock markets.

1.4.2 The Feedstock Constraint

This is the fundamental limit on marine biofuels, and it deserves honesty: **there is not enough sustainable feedstock to decarbonize shipping with biofuels alone.**

The primary waste-derived feedstocks are:

Feedstock	Global Annual Availability	Current Primary Use
Used cooking oil (UCO)	~15 million MT	Road FAME, SAF
POME (palm oil mill effluent)	~5–8 million MT	FAME, power generation
Animal fats/tallow	~10–12 million MT	Oleochemicals, FAME
Agricultural residues	Very large (theoretical)	Mostly uncollected

Table 1.7: Primary waste-derived biofuel feedstocks — global availability

Marine biofuels compete for these feedstocks with road transport (FAME mandates in Europe, North America, and Asia) and aviation (sustainable aviation fuel — SAF — which can command premium prices). Aviation currently pays more per tonne for SAF than shipping pays for marine biofuel, which means SAF tends to win the bidding for limited feedstock.

The practical ceiling for marine biofuels from waste-derived feedstocks is estimated at **5–8% of global marine fuel consumption** by 2030 — roughly 15–25 million tonnes per year. This makes biofuels a **bridge fuel**, not a destination. They buy time while ammonia, green methanol, and hydrogen infrastructure scales.

Chapter 3 covers feedstock economics in depth. For now, the key point is: biofuels can meaningfully reduce your fleet's emissions today, and they are economically rational under current and projected regulations. But they will not carry the entire decarbonization burden alone.

1.4.3 The Strategic Window

There is a window of approximately **5–8 years** (2025–2033) where biofuels are the most cost-effective compliance tool for most of the existing fleet. During this window:

1. **IMO GFS and FuelEU targets are achievable** with B24–B30 blends on existing vessels
2. **Ammonia and hydrogen engines are not yet commercially available** at fleet scale
3. **Green methanol production is severely limited** and allocated primarily to newbuild container ships
4. **EU ETS and FuelEU penalties** make fossil-only strategies progressively more expensive

After 2033, the math changes. IMO targets tighten toward -70% by 2040, and biofuels alone may not close the gap. Newbuild vessels ordered today with dual-fuel methanol or ammonia capability will be entering service. Green fuel production may have scaled.

The prudent strategy: **use biofuels now to decarbonize the fleet you have, while ordering newbuilds with future fuel flexibility.** This is not a binary choice between biofuels and alternatives. It is a portfolio approach — biofuels for the near term, alternative fuels for the long term, with the mix shifting over time.

1.5 What This Book Will Cover

This book is organized to serve the people who need to make biofuel decisions — not the people writing policy papers about them.

Chapter 2 dives into the chemistry: what FAME, HVO, and co-processed fuels actually are, how feedstock determines fuel properties, and why the same "biofuel" name can describe fuels that behave very differently in your engines.

Chapter 3 tackles the real constraint: feedstock economics. Where the stuff comes from, what it costs, who else wants it, and how sustainability certification chains work.

Chapter 4 covers procurement: how to specify biofuel in RFQs, what blend ratios mean in practice, how pricing works, who the suppliers are, and what contract terms you need that are unique to biofuels.

Chapter 5 is for the engineers: which engines can burn which blends, what modifications matter (and what don't), and what the OEMs actually say versus what the sales literature claims.

Chapter 6 addresses the operational reality that catches people off guard: biofuels degrade differently than fossil fuels, storage stability varies by blend and climate, and fuel management requires different practices.

Chapter 7 provides a deep dive on regulatory compliance — worked examples showing how B24, B30, and B100 scenarios calculate under IMO GFS, FuelEU Maritime, and EU ETS, with step-by-step calculations you can adapt to your own fleet.

Chapter 8 covers the documentation trail: sustainability certification (ISCC, RSB), mass balance vs. book-and-claim systems, chain of custody from feedstock to bunker barge, and how to spot fraudulent sustainability claims.

Chapter 9 addresses bunkering operations: what is different about biofuel deliveries, sampling protocols, BDN requirements, and quality testing beyond standard ISO 8217.

Chapter 10 presents real-world case studies — biofuel bunkering gone wrong and gone right — in the same Situation / Decision / Analysis / Outcome format used in *Bunkering101*.

Chapter 11 maps the infrastructure: which ports have biofuel available, at what blends, from which suppliers, and at what price premiums.

Chapter 12 looks ahead: advanced feedstocks, next-generation biofuels, the scaling ceiling, and a decision framework for five-year and ten-year fuel procurement planning.

1.6 Chapter Summary

- The IMO's revised GHG Strategy requires 20–30% emissions reduction by 2030 and net-zero by 2050. Binding mid-term measures (Global Fuel Standard, economic mechanism) are being finalized.

- FuelEU Maritime took effect January 2025 with escalating GHG intensity targets and a EUR 2,400/t penalty for non-compliance. EU ETS covers maritime CO2 with 100% liability from 2026.
- Biofuels are the only immediately available, drop-in decarbonization solution that works in existing engines through existing infrastructure.
- Current adoption is small (~0.1–0.3% of marine fuel) but growing rapidly. Major carriers (Maersk, CMA CGM, MSC) are already regular users.
- Feedstock availability constrains biofuels to roughly 5–8% of marine fuel by 2030 — a bridge fuel, not a final solution.
- The strategic window is 2025–2033: use biofuels to decarbonize existing fleet while newbuilds with future fuel capability enter service.
- The economics are shifting: regulatory penalties on fossil fuel are rising fast enough to make biofuels rational on a total-cost basis.

Next: Chapter 2 — Biofuel Chemistry & Classification

Get the Full Guide

This is a **free sample chapter** from *Biofuels at Sea: The Maritime Professional's Guide to Alternative Fuels.*

The full edition includes:

- **12 chapters** covering biofuel chemistry and classification, feedstock economics, procurement, engine and fuel-system compatibility, storage stability, regulatory compliance, sustainability certification, bunkering operations, case studies, hub infrastructure and the 2026–2040 outlook
- **Appendices** with a biofuel specification quick reference, engine compatibility matrix, procurement checklist, regulatory worksheets, sustainability documentation templates and a glossary
- Worked examples and decision frameworks for blending, certification and cost

Get the complete guide: bunkering101.com